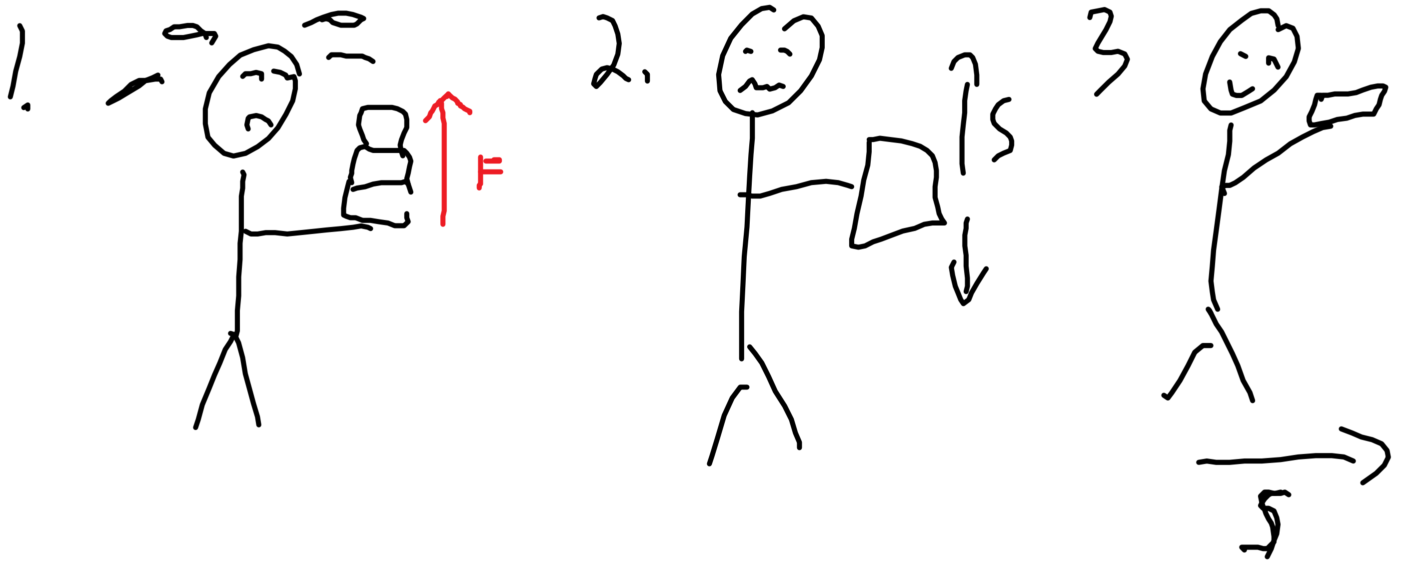
Who is doing more work?
3 students

1. Calvin is hold a stack of books motionless.
2. Alvin is lifting a book up and down.
3. Helen is walking, holding a book.



Alvin is fighting gravity - changes in energy - force is moving

W=Fs
work, in Joules, J=Nm
F is the force, in N
s is displacement (d is the symbol in book), in m.
when the force is in the direction of displacement.
Work is the vector dot product of force and displacement.
Work is a scalar - no direction.

given this definition, who is doing work?
Calvin - large force but no displacement, so Calvin does no work.
Helen - The force on the book is perpendicular to the displacement, so she does no work.
Alvin - does positive work lifting the book, negative work lowering the book (F is opposite s) so the net work is 0

so students don't do work.

Work can also be defined/discussed as the change in energy.
Work energy theorem

$W = \Delta Energy$

What is energy?
energy is the ability to do work.
Energy is conserved.

physical work = Fs

Power is the rate of doing work or the rate of change in energy.

$P = \Delta W / \Delta t$
units, Watt, W=J/s

horsepower, hp = 746W

eg. 1. A 50.0 kg student runs up 23 stairs 0.27m wide and 0.12m high in 3.0 s.

a) what is the force of gravity on the student?

F_g=mg = 50.0kg x 9.81N/kg = 50x9.81=490.5 N

490N

a) What is the total change in height of the stairs?

23x0.12=2.76 m = 2.8m

a) What is the work done by the student against gravity?

W=Fs = 490.5x2.76=1,353.78 = 1.4x10^3J

a) What is the work done by gravity?

W = -1.4x10^3J F is opposite s, so negative

a) What is the work done by the normal force?

W= 0 doesn't move

b) What is the power of the student, in W, in hp?

P = W/t = 1,353.78/3=451.26 =450W

451.26/746=0.6049 = 0.60hp

2. A 100W light bulb is left on 8.0 hours a day for a year. BC hydro charges about 12 cents per kilowatt-hour. How much does is cost for high efficiency bulbs that give off equivalent light

kilowatt-hour. How much does is cost for high efficiency bulbs that give off equivalent light using only 25W?

3. Run stairs, calculate your power.

   1a) p=mv = 0.12 or 0.18kg x 15m/s =1.80kgm/s or 2.7kgm/s

a) Δp=pf-pi = mvf-mvi = -0.12kgm/s or -0.18kgm/s
b) Δp=pf-pi = mvf-mvi = -1.80kgm/s or -2.7kgm/s
c) Δp=pf-pi = mvf-mvi = -3.4kgm/s or -5.2kgm/s
d) Fnet = Δp/Δt = -3.4 or -5.2/0.020s = -170N or -260N

1. a) total momentum before the explosion = total momentum after

   $0=m_a v_a + m_b v_b$

   $v_b = -m_a v_a / mb$ = -1.3m/s or -1.6m/s

   1.3m/s opposite the other cart

a) F=Δp/Δt internal force between the carts, so just look at one cart

   F= 3kg x 1.3m/s/0.20s = 2kg x 2m/s/0.02s = 20N

   F= 5kg x 1.6m/s/0.20s = 2kg x 4m/s/0.02s = 40N

1. total momentum before = total momentum after

   0.035kgx350m/s + 0 = (0.035kg + 0.35 or 0.45kg)v

v = 25.3 m/s or 31.8m/s

2. $F\Delta t=\Delta p$ = area under the graph
85Nx20s= 1700Ns = mvf-mvi
vf = [1700Ns + (4or 3kgx14m/s)]/4or3kg
439m/s or 581m/s
4.4×10^2m/s or 5.8×10^2m/s